Title: LASER SYSTEM USING ULTRA-SHORT LASER PULSES
Inventor(s): M. Dantus et al.
Atty. Ref.: 6550-000057/CPE

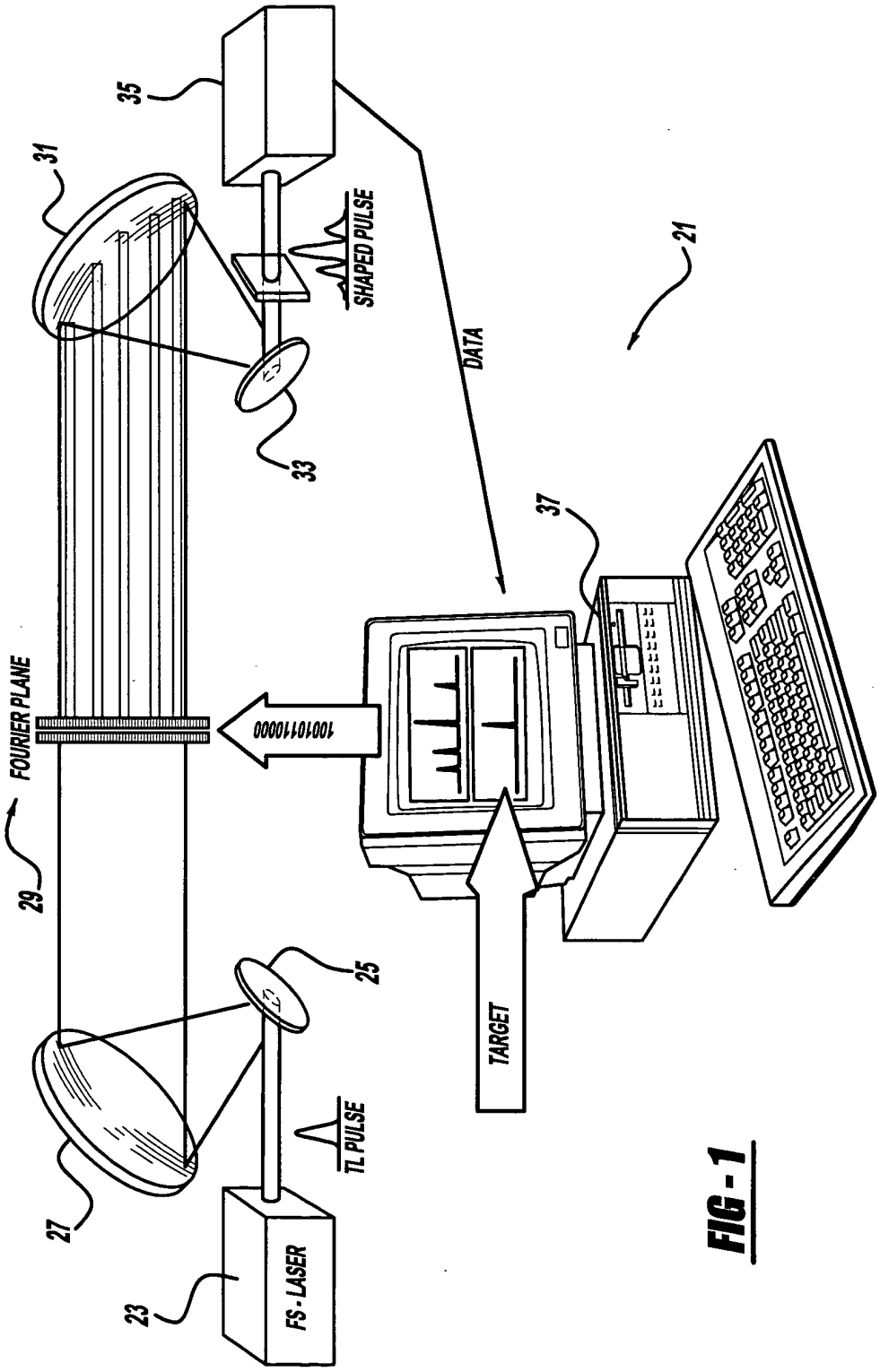

FIG - 1

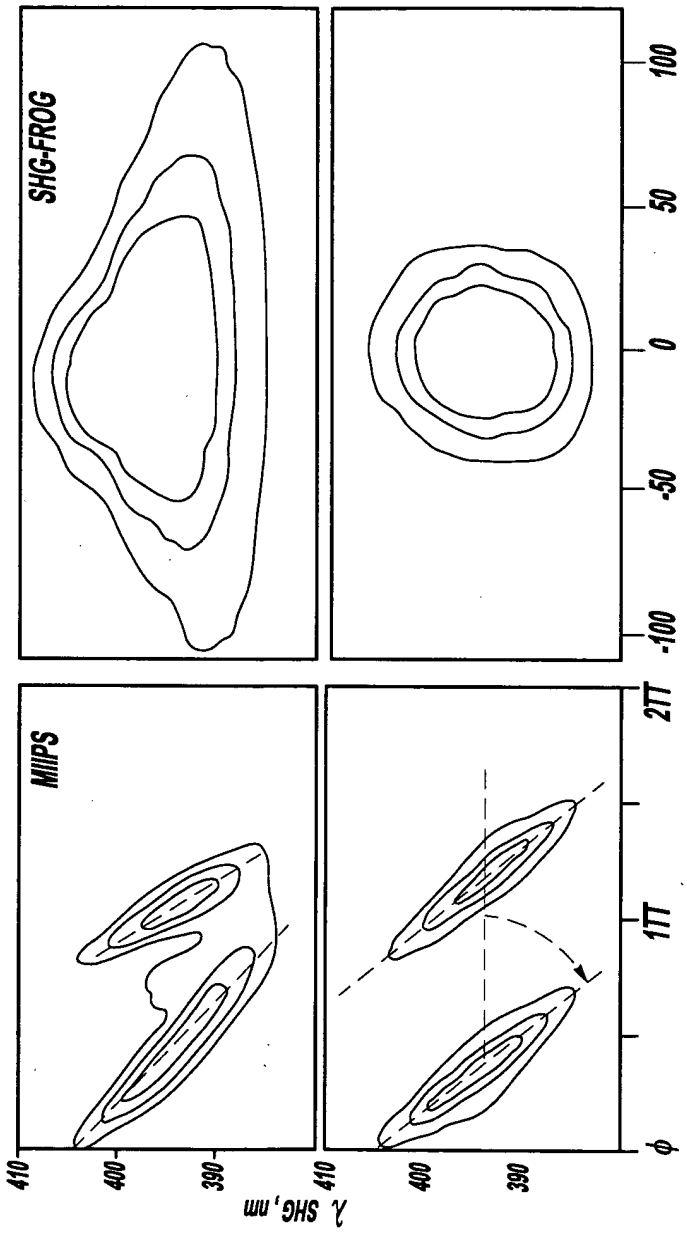

FIG - 2a

FIG - 2b

FIG - 2c

FIG - 2d

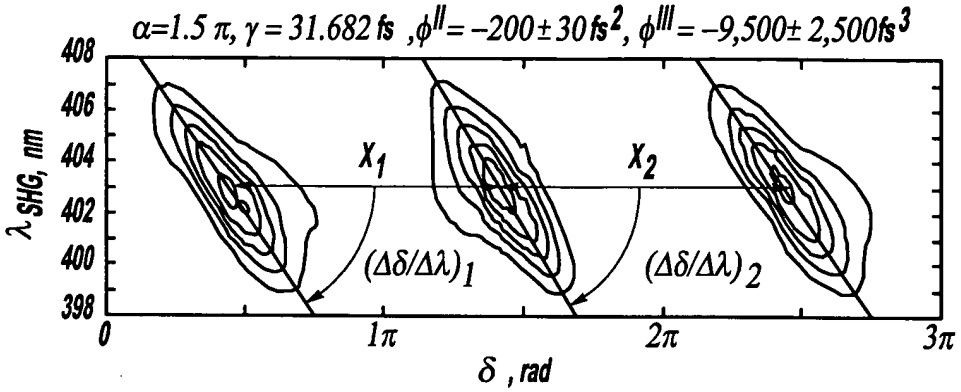
α=1.5 π, γ = 31.682 fs ,φ^II = −200 ± 30 fs^2, φ^III = −9,500 ± 2,500 fs^3
λ SHG, nm
408
406
404
402
400
398
X1
X2
(Δδ/Δλ)1
(Δδ/Δλ)2
0
1π
2π
3π
δ , rad

FIG - 3

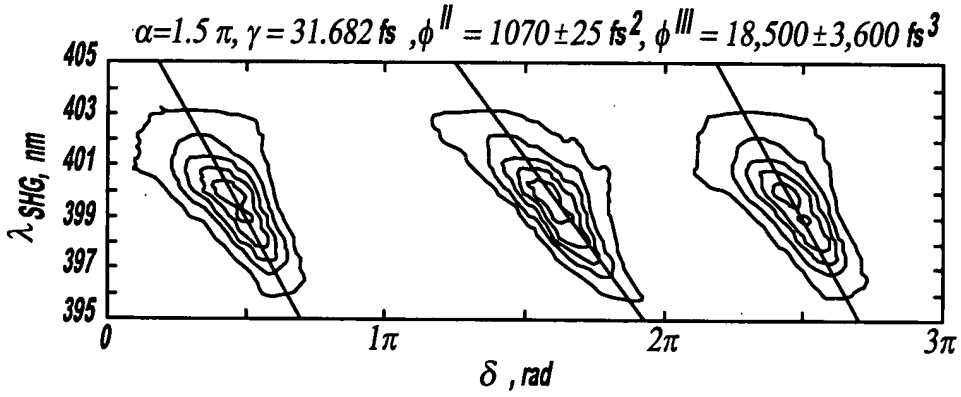
α=1.5 π, γ = 31.682 fs ,φ^II = 1070 ± 25 fs^2, φ^III = 18,500 ± 3,600 fs^3
λ SHG, nm
405
403
401
399
397
395
0
1π
2π
3π
δ , rad

FIG - 4a

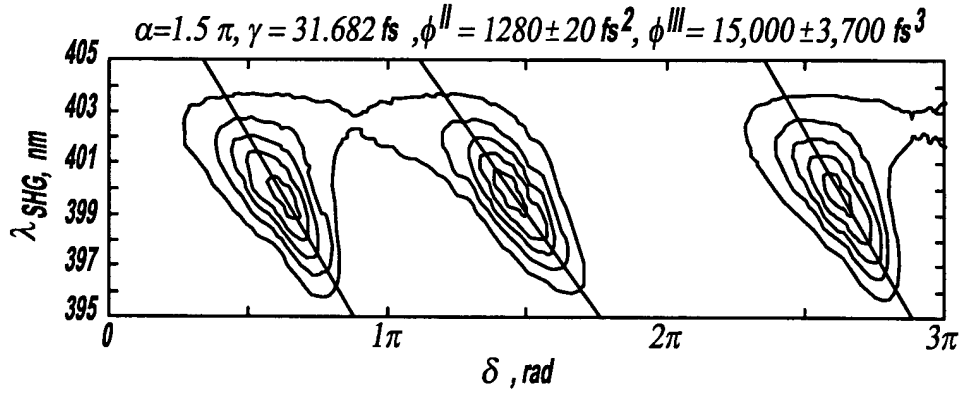
α=1.5 π, γ = 31.682 fs ,φ^II = 1280± 20 fs^2, φ^III = 15,000 ±3,700 fs^3
405
403
401
399
397
395
λ SHG, nm
0
1π
2π
3π
δ , rad

FIG - 4b

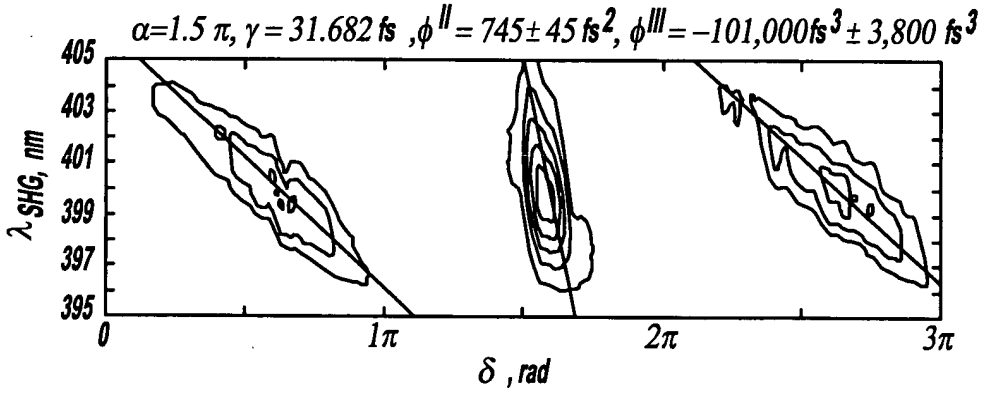
α=1.5 π, γ = 31.682 fs ,φ^II = 745± 45 fs^2, φ^III = −101,000fs^3 ± 3,800 fs^3
405
403
401
399
397
395
λ SHG, nm
0
1π
2π
3π
δ , rad

FIG - 4c

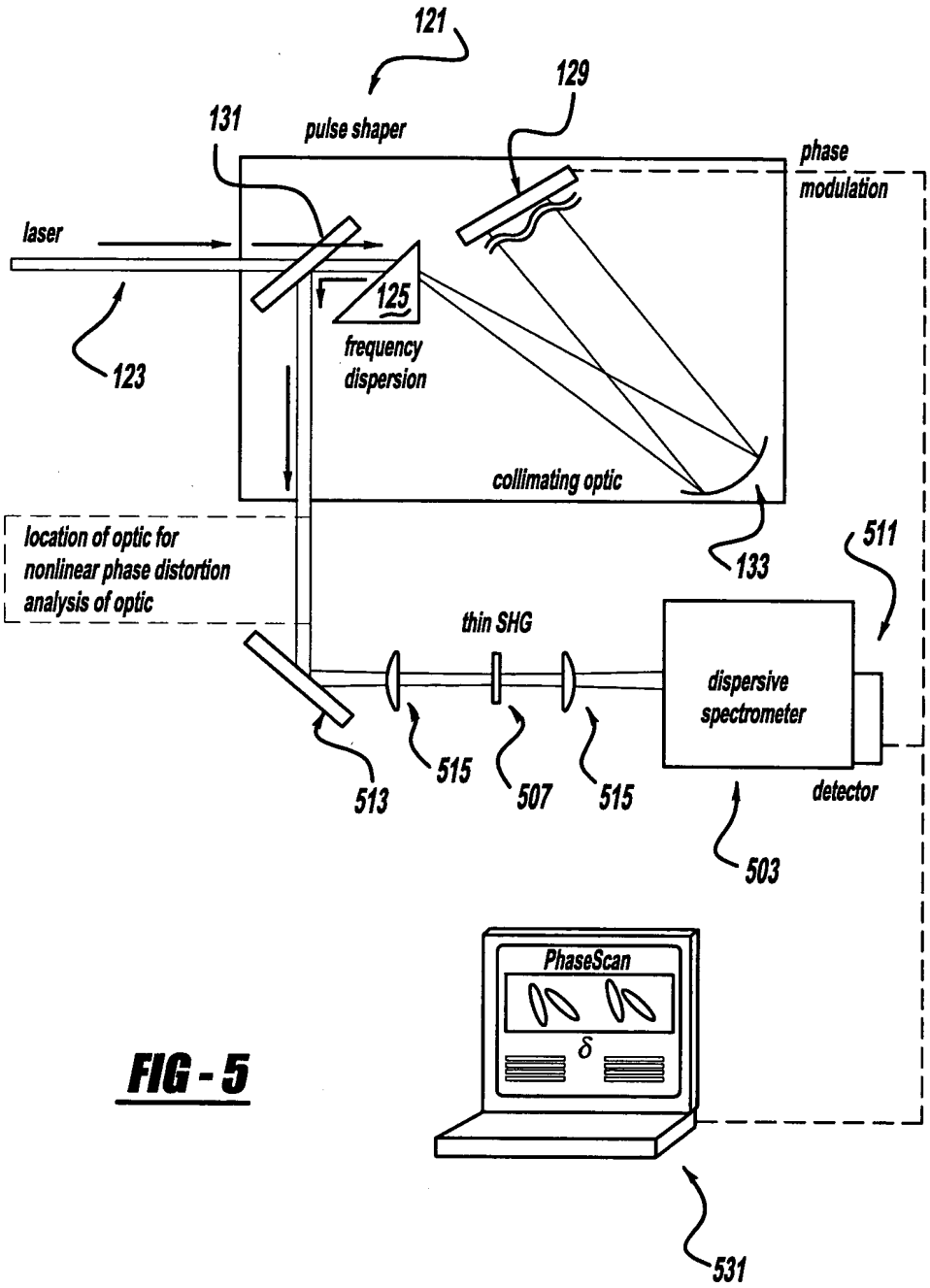
121
129
131
pulse shaper
phase
modulation
laser
125
frequency
dispersion
123
collimating optic
133
511
location of optic for
nonlinear phase distortion
analysis of optic
thin SHG
dispersive
spectrometer
513
515
507
515
detector
503
PhaseScan
δ
531

FIG - 5

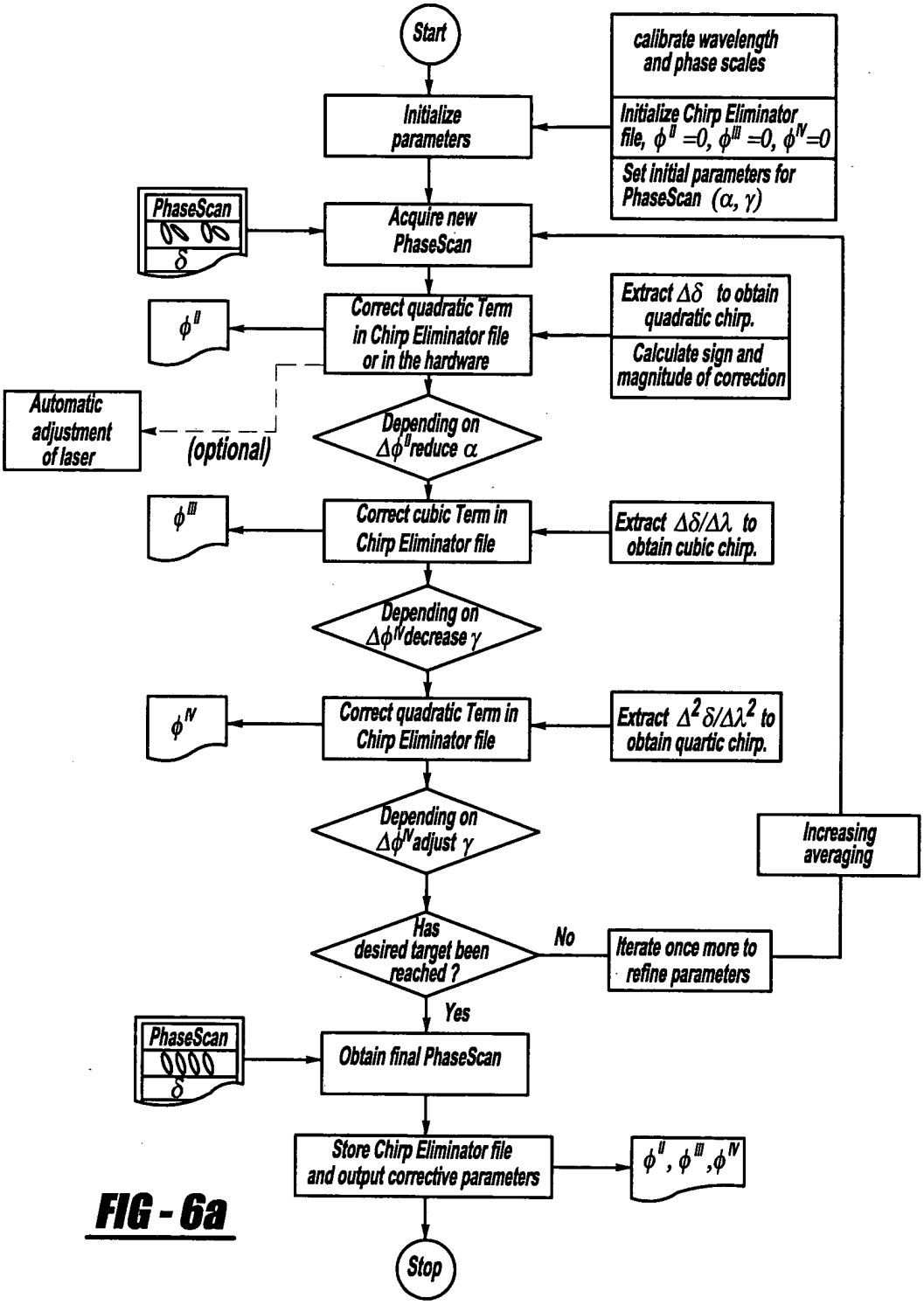
Start
calibrate wavelength and phase scales
Initialize parameters
Initialize Chirp Eliminator file, $\phi^{II}=0$, $\phi^{III}=0$, $\phi^{IV}=0$
Set initial parameters for PhaseScan (α, γ)
PhaseScan
δ
Acquire new PhaseScan
ϕ^{II}
Correct quadratic Term in Chirp Eliminator file or in the hardware
Extract $\Delta\delta$ to obtain quadratic chirp.
Calculate sign and magnitude of correction
Automatic adjustment of laser
(optional)
Depending on $\Delta\phi^{II}$ reduce α
ϕ^{III}
Correct cubic Term in Chirp Eliminator file
Extract $\Delta\delta/\Delta\lambda$ to obtain cubic chirp.
Depending on $\Delta\phi^{IV}$ decrease γ
ϕ^{IV}
Correct quadratic Term in Chirp Eliminator file
Extract $\Delta^2\delta/\Delta\lambda^2$ to obtain quartic chirp.
Depending on $\Delta\phi^{IV}$ adjust γ
Increasing averaging
Has desired target been reached ?
No
Iterate once more to refine parameters
Yes
PhaseScan
δ
Obtain final PhaseScan
Store Chirp Eliminator file and output corrective parameters
ϕ^{II}, ϕ^{III}, ϕ^{IV}
Stop

FIG - 6a

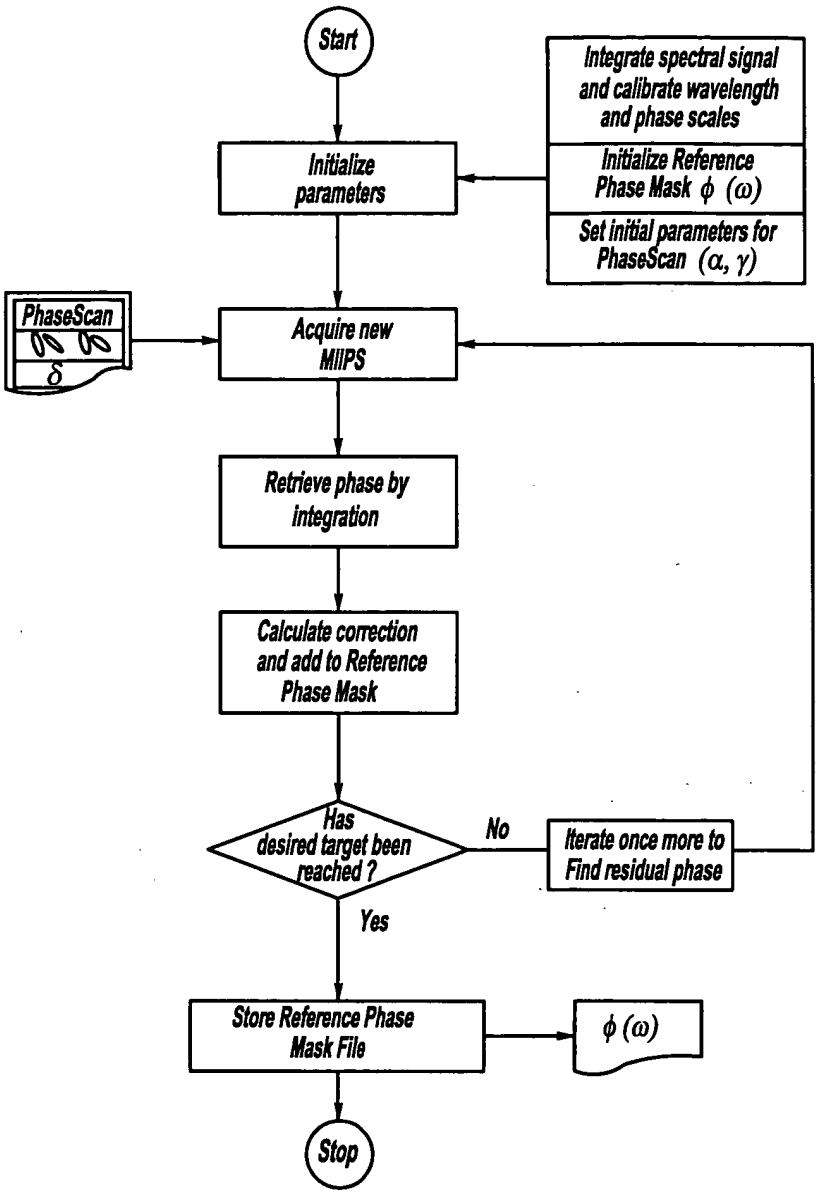
Start
Integrate spectral signal and calibrate wavelength and phase scales
Initialize parameters
Initialize Reference Phase Mask ϕ (ω)
Set initial parameters for PhaseScan (α, γ)
PhaseScan
Acquire new MIIPS
Retrieve phase by integration
Calculate correction and add to Reference Phase Mask
Has desired target been reached ?
No
Iterate once more to Find residual phase
Yes
Store Reference Phase Mask File
ϕ (ω)
Stop

FIG - 6b

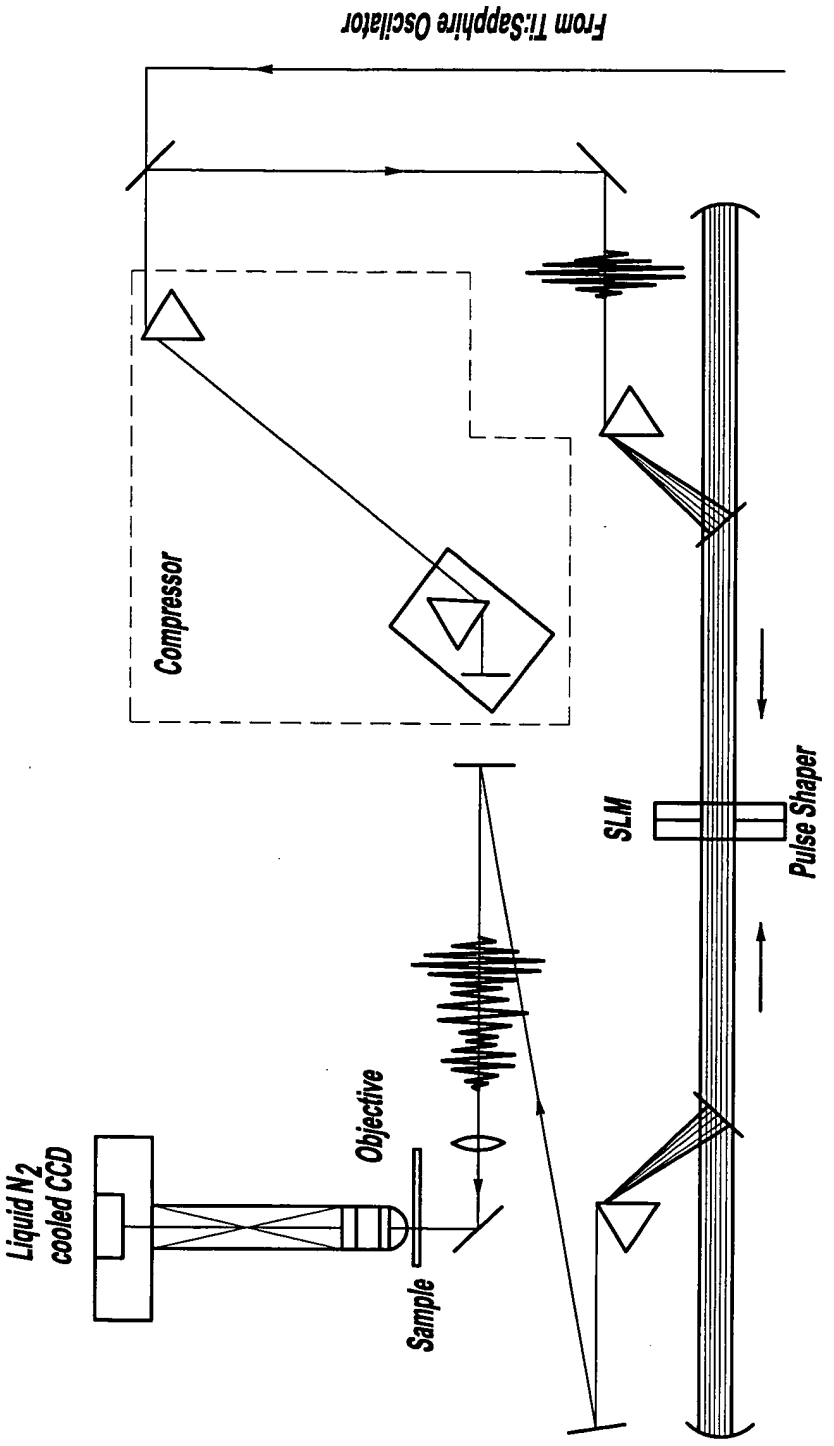
From Ti:Sapphire Oscillator
Compressor
SLM
Pulse Shaper
Objective
Liquid N_2 cooled CCD
Sample

FIG - 7

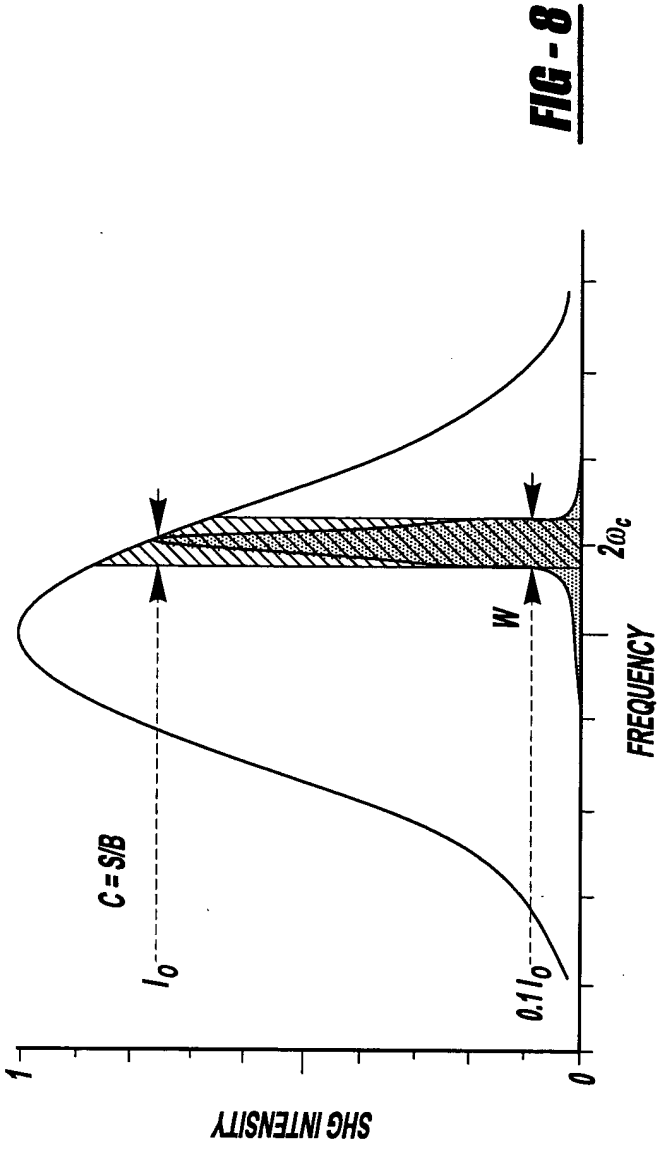
SHG INTENSITY
1
0
C = S/B
I_o
$0.1I_o$
W
$2\omega_c$
FREQUENCY

FIG - 8

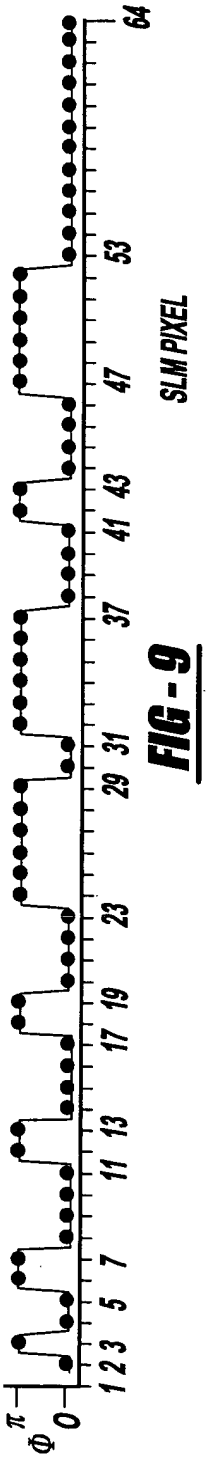
Φ
π
0
1 3 5 7 11 13 17 19 23 29 31 37 41 43 47 53 64
SLM PIXEL

FIG - 9

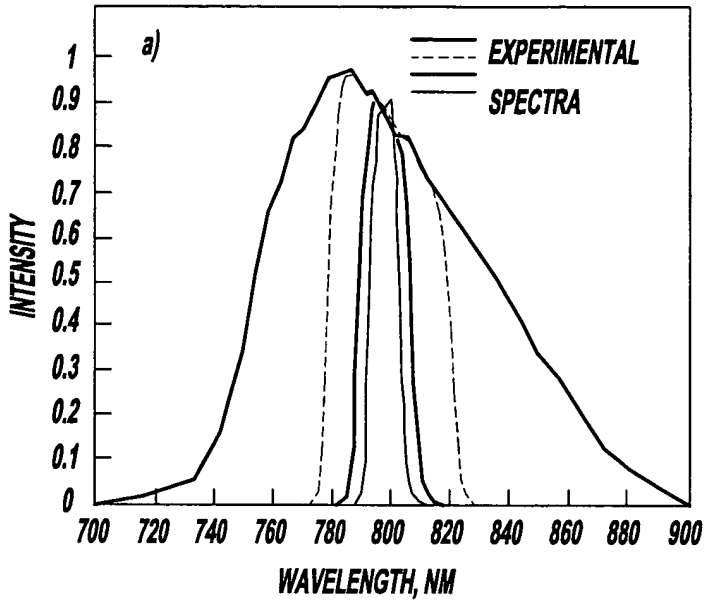

FIG - 10a

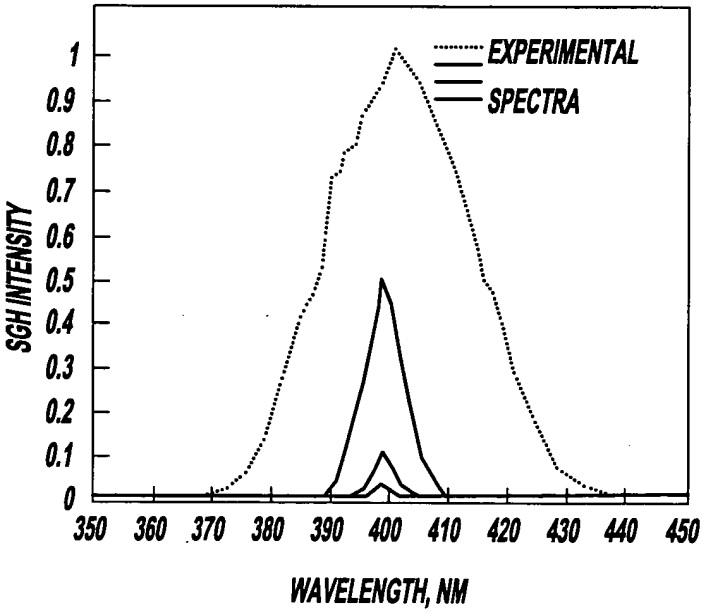

FIG - 10b

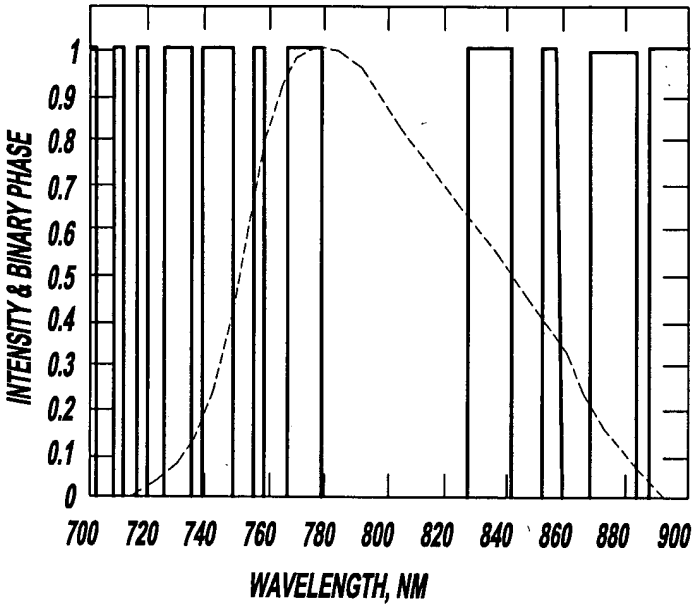

FIG - 11a

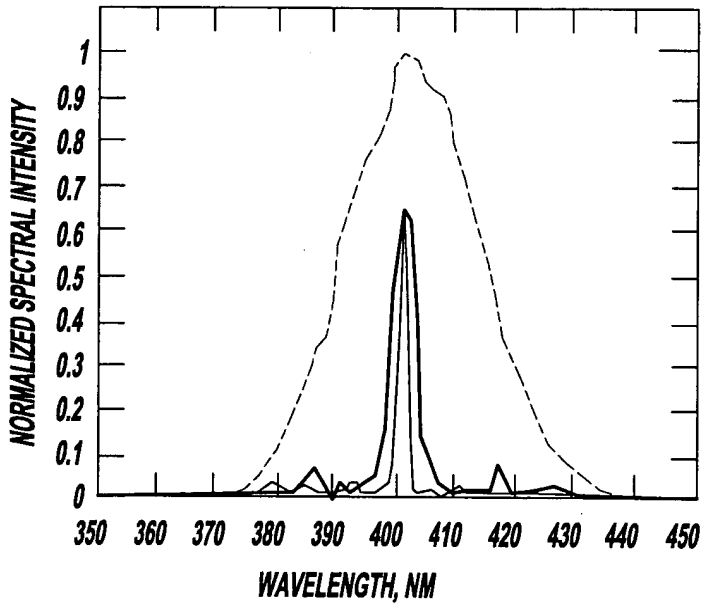

FIG - 11b

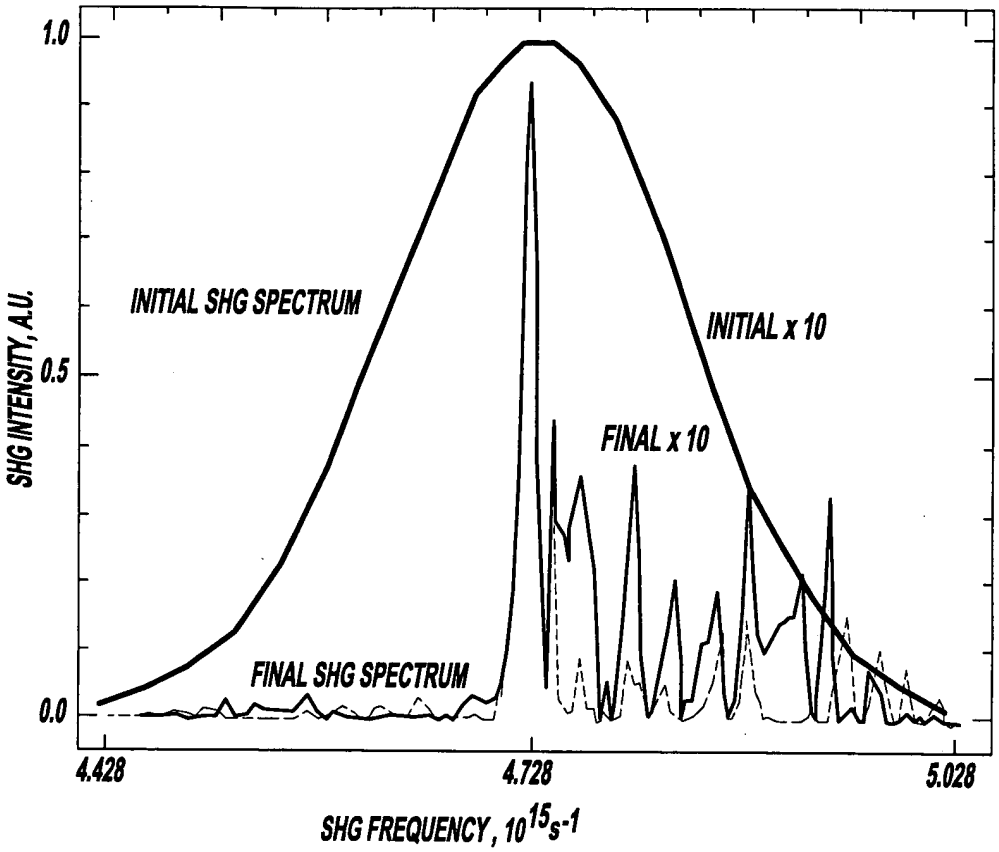
1.0
0.5
0.0
SHG INTENSITY, A.U.
INITIAL SHG SPECTRUM
INITIAL x 10
FINAL x 10
FINAL SHG SPECTRUM
4.428
4.728
5.028
SHG FREQUENCY, $10^{15}s^{-1}$

FIG - 12a

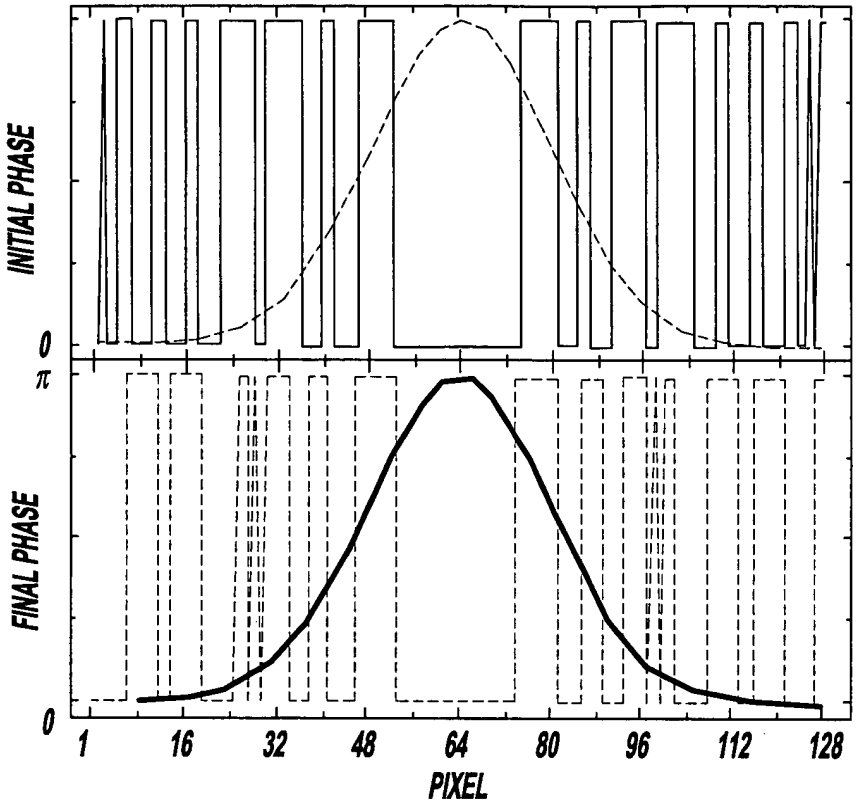

FIG - 12b

FIG - 12c

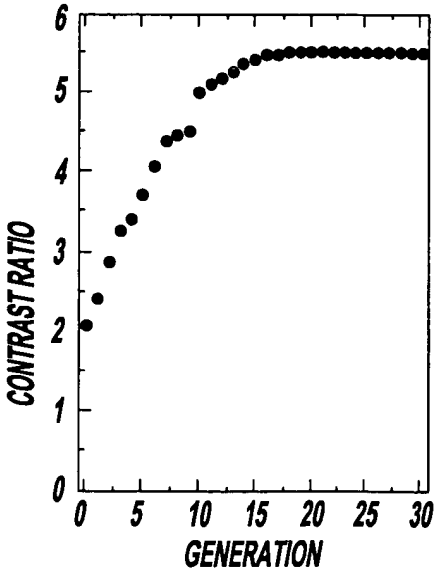

FIG - 12d

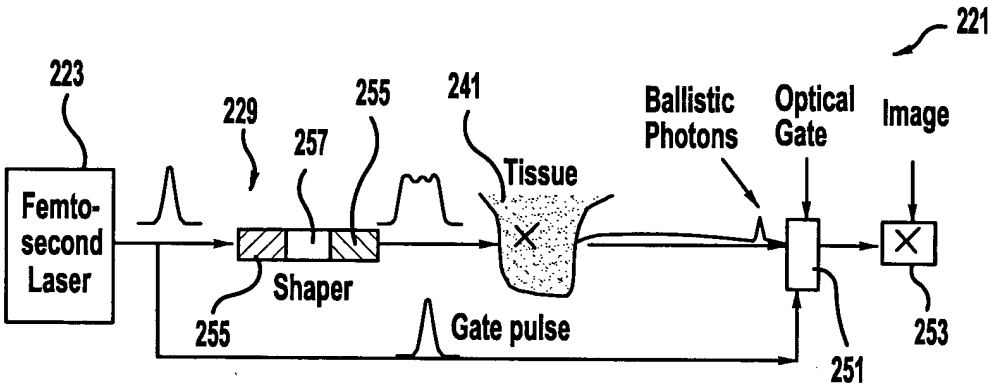
221
223
229
257
255
241
Ballistic Photons
Optical Gate
Image
Tissue
Femto-second Laser
Shaper
255
Gate pulse
253
251

FIG - 13

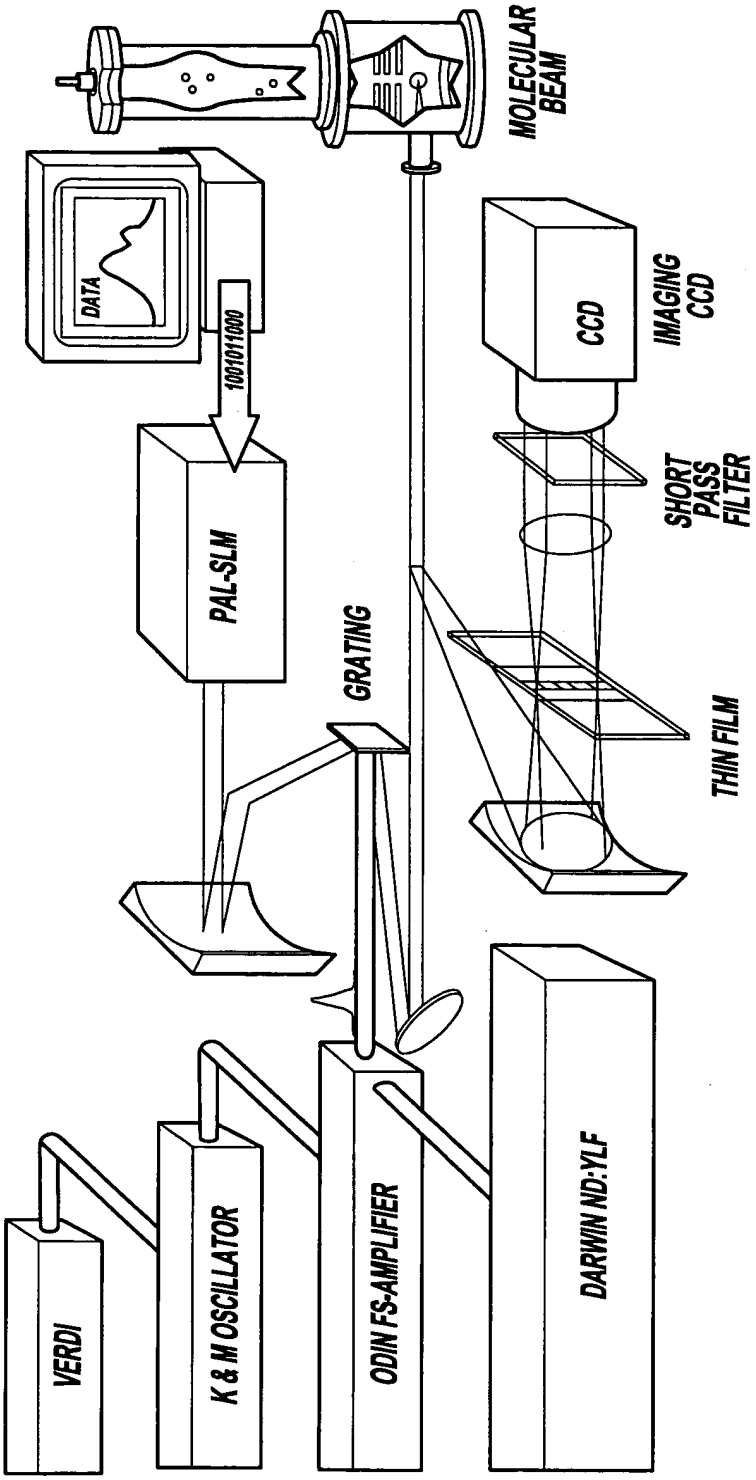
MOLECULAR BEAM
DATA
1001011000
CCD
IMAGING CCD
SHORT PASS FILTER
PAL-SLM
GRATING
THIN FILM
VERDI
K & M OSCILLATOR
ODIN FS-AMPLIFIER
DARWIN ND:YLF

FIG - 14

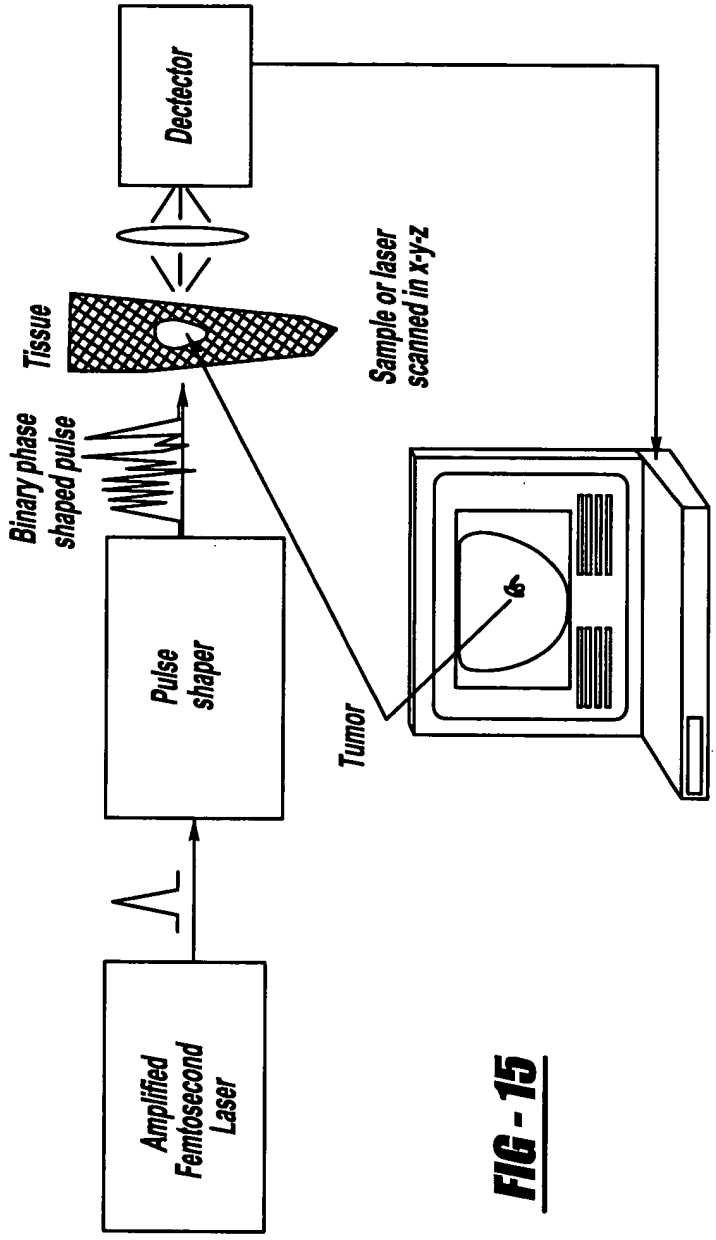
Dectector
Tissue
Sample or laser scanned in x-y-z
Binary phase shaped pulse
Pulse shaper
Tumor
Amplified Femtosecond Laser

FIG - 15

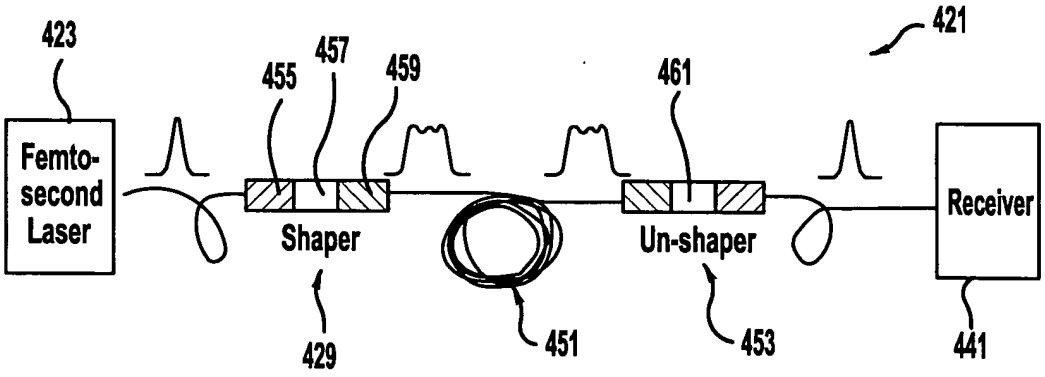

FIG - 16

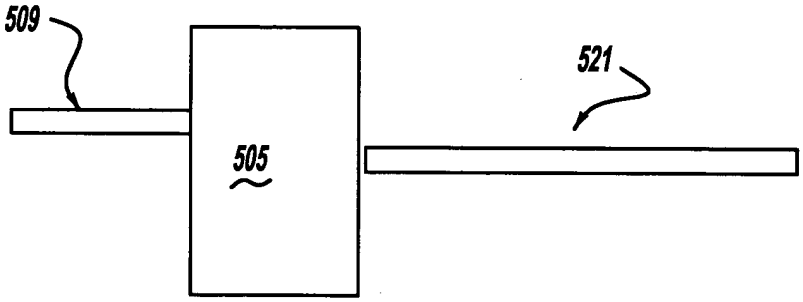

FIG - 18a

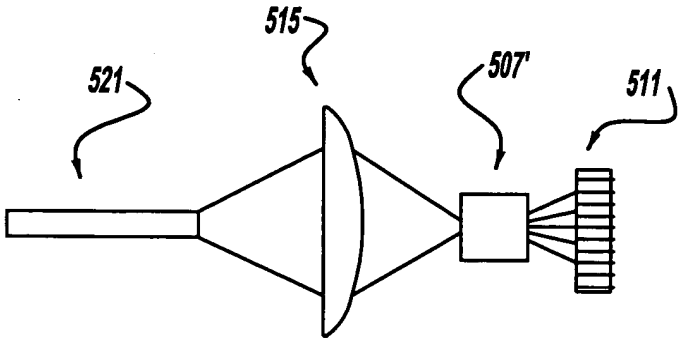

FIG - 18b

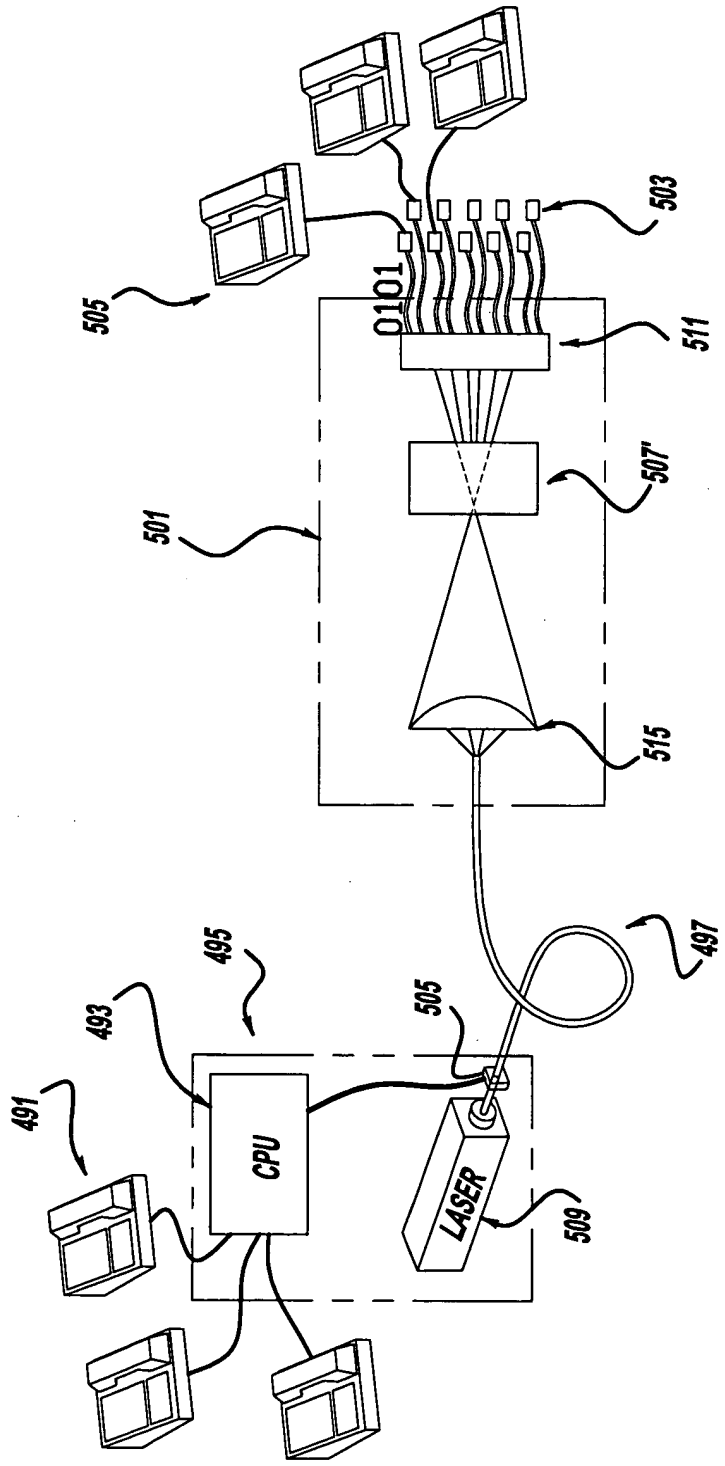

FIG - 17

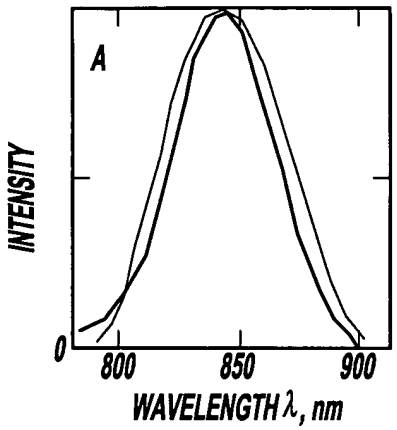

FIG - 19a

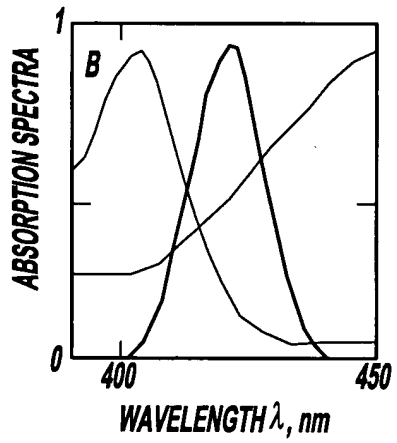

FIG - 19b

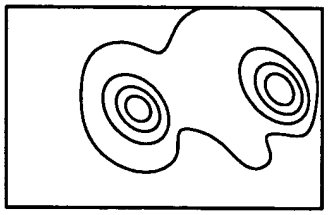

FIG - 20a

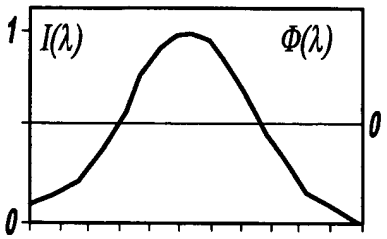

FIG - 20d

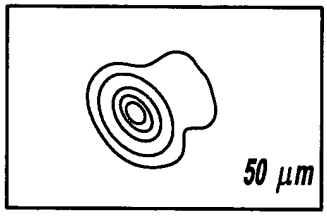

FIG - 20b

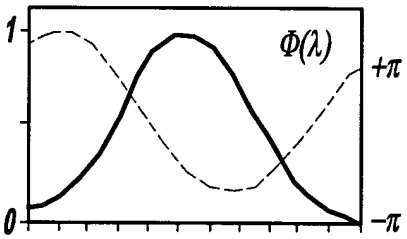

FIG - 20e

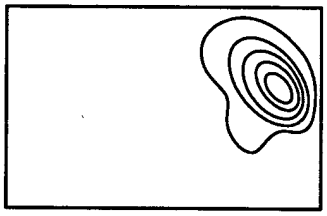

FIG - 20c

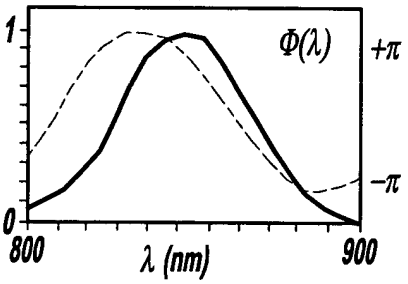

FIG - 20f

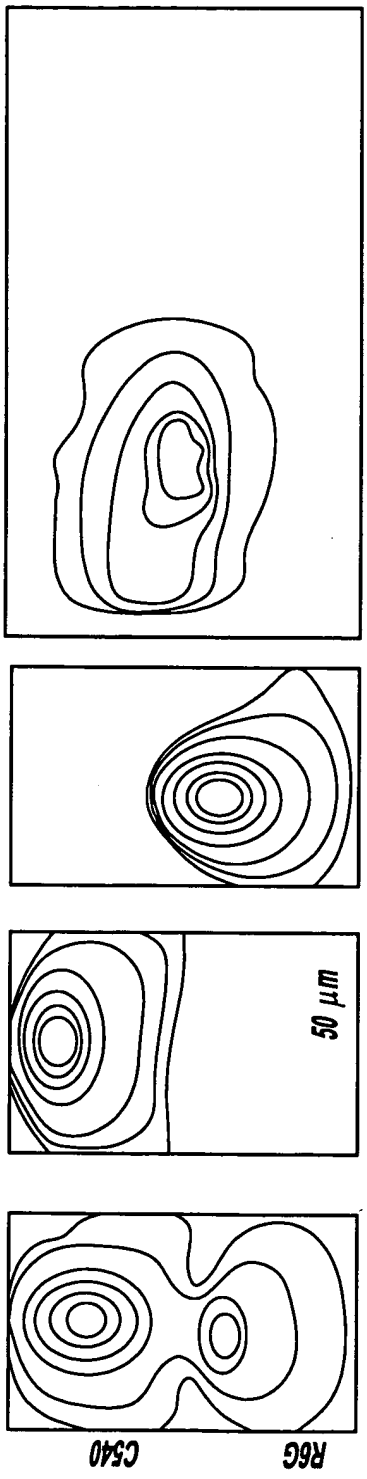

FIG - 21d

FIG - 21c

FIG - 21b

FIG - 21a

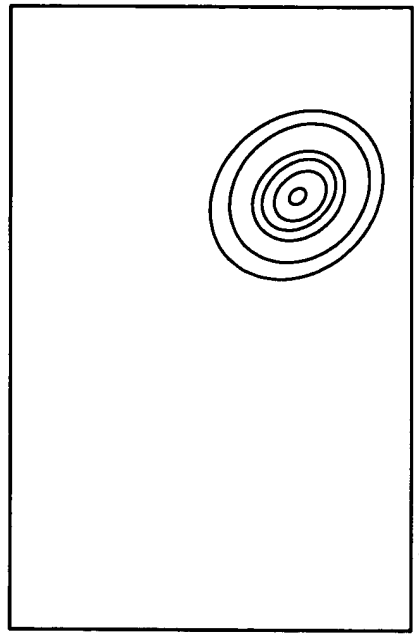

FIG - 22d

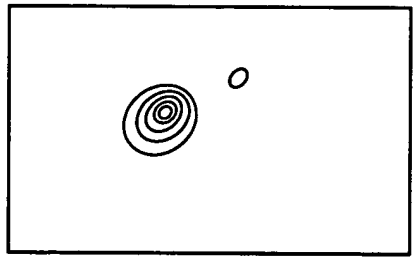

FIG - 22c

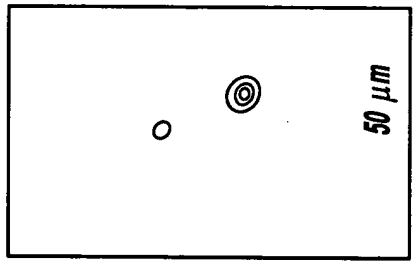

FIG - 22b

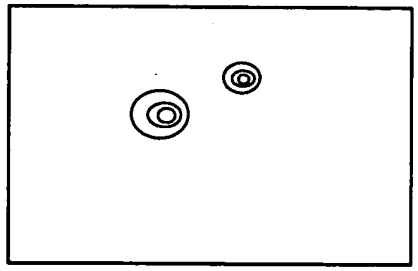

FIG - 22a

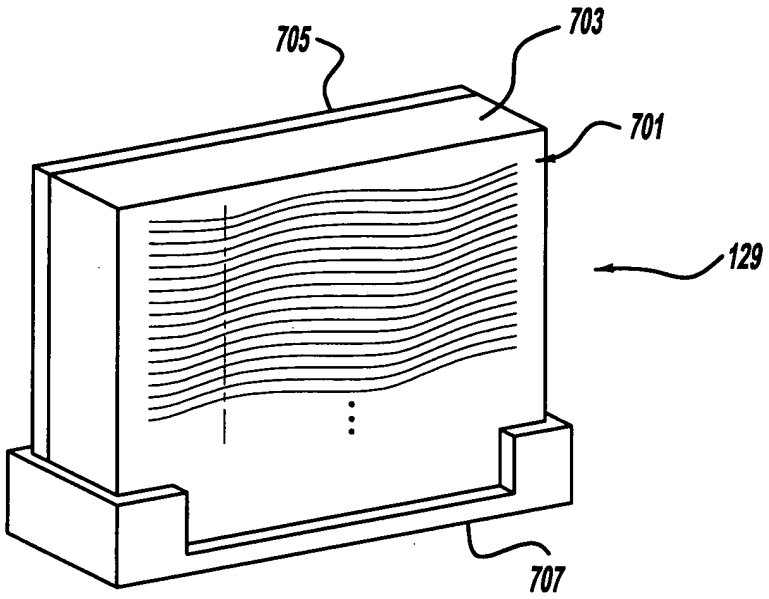

FIG - 23